P. D. Jeitam.

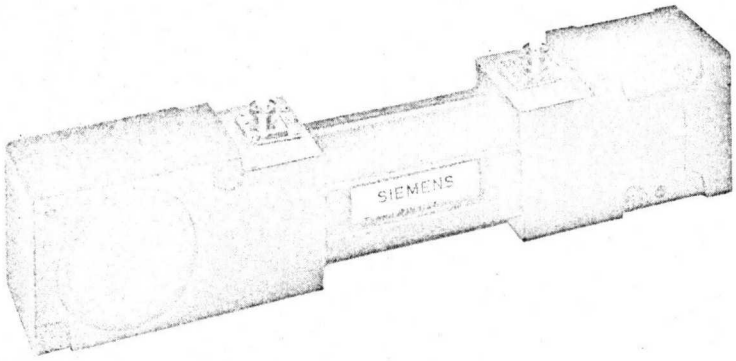
Conduction cooled power traveling wave tube with long life and high reliability for broadband radio relay systems with a power output of 22 W in the frequency range 10.7 to 13.25 GHz.

By using the most contemporary technic (double stage collector) an efficiency up to 38% is reached. The dissipated heat is low and indipendent of the RF input power. If the RF input power fails, no temperature rise will occur.

The tube is focused by an integrated periodic permanent magnet.

The RF power is coupled in and out by way of coaxial connections.

For operation of the tube RW 1125 a power supply can be delivered under the type-designation RWN 1125 (supply voltage 24 V, by choice minus or plus connected with case; other supply voltages on request).



Weight:	approx. 1.4 kg (3.1 lbs)
Dimensions:	approx. 42 mm × 52 mm × 262 mm (1.65" × 2.05" × 10.3")
RF connections:	Siemens socket connector 1.4/4.4 (50 Ω)
Mounting Position:	any

Heating

Heater voltage	U_F	6.3±0.2	V [1]
Heater current	I_F	0.64	A
Preheating time	t_h	none	

indirected by dc, +pole on cathode, parallel supply.
Metal capillary dispenser cathode.

Characteristics (f = 12.7 GHz, I_K = 43 to 53 mA)

		min	nom	max	
Gain	Vp		40.5		dB
Gain slope (Load VSWR ≦ 1.2)	ΔVp/Δf		0.01		dB/MHz
VSWR cold	s			1.8	[2]
Cold attenuation	α	80			dB

Typical Operation for P_2 = 22 W

Frequency range	f	10.7 to 11.7	11.7 to 12.7	12.7 to 13.25	GHz
Power output	P_2	22	22	22	W
Power input	P_1	2±1 dB	2±1 dB	2±1 dB	mW
Collector 1 voltage	U_{C1}	1450	1450	1300	V
Collector 2 voltage	U_{C2}	600	600	550	V
Helix voltage	U_H	3100 to 3500	3100 to 3500	3100 to 3500	V [3]
Grid 2 voltage	U_{G2}	≈2600	≈2600	≈2600	V [4]
Cathode current	I_K	43 to 53	43 to 53	43 to 55	mA
Collector 1 current with Rf	I_{C1}	≈27	≈27	≈31	mA
Collector 2 current with RF	I_{C2}	≈20	≈20	≈18	mA
Collector 1 current without RF	$I_{C1\,0}$	≈ 3	≈ 3	≈ 3	mA
Collector 2 current without RF	$I_{C2\,0}$	≈45	≈45	≈45	mA
Helic current	I_H	≈1	≈ 1	≈ 1	mA
Grid 2 current	I_{G2}	≦±0.1	≦±0.1	≦±0.1	mA
Noise figure	F	≦27	≦27	≦27	dB
AM/PM conversion	k_p	≦ 5	≦ 5	≦ 5	°/dB [5]
Total efficiency	η_{total}	≈38	≈38	≈38	%

[1] If the maximum variation of the heater voltage exceeds the absolute limits of ± 0.2 V, the operating performance of the tube will be impaired and its life shortened.
[2] At input and output of cold tube in the frequency range 10.7 to 13.25 GHz.
[3] A fix setting value for any frequency ranges will be stated later.
[4] It is adjusted at a power input of 2 mW for a power output of 11 W.
[5] AM/PM conversion is the phase shift of the output signal when changing the input by 1 dB.

Typical Operation for $P_2 = 11$ W

Frequency range	f	10.7 to 11.7	11.7 to 12.7	12.7 to 13.25	GHz
Power output	P_2	11	11	11	W
Power input	P_1	1±1 dB	1±1 dB	1±1 dB	mW
Collector 1 voltage	U_{C1}	1200	1150	1100	V
Collector 2 voltage	U_{C2}	600	600	550	V
Helix voltage	U_H	2900 to 3400	2900 to 3400	2900 to 3400	V [1]
Grid 2 voltage	U_{G2}	≈2200	≈2200	≈2200	V [2]
Cathode current	I_K	33 to 43	33 to 43	33 to 43	mA
Collector 1 current with RF	I_{C1}	≈14	≈14	≈14	mA
Collector 2 current with RF	I_{C2}	≈23	≈23	≈23	mA
Collector 1 current without RF	$I_{C1\,O}$	≈ 2	≈ 2	≈ 2	mA
Collector 2 current without RF	$I_{C2\,O}$	≈36	≈36	≈36	mA
Helix current	I_H	≈ 1	≈ 1	≈ 1	mA
Grid 2 current	I_{G2}	≦±0.1	≦±0.1	≦±0.1	mA
Noise figure	F	≦26	≦26	≦26	dB
AM/PM conversion	k_p	≦4.5	≦4.5	≦4.5	°/dB[3]
Total efficiency	η_{total}	≈30	≈30	≈30	%

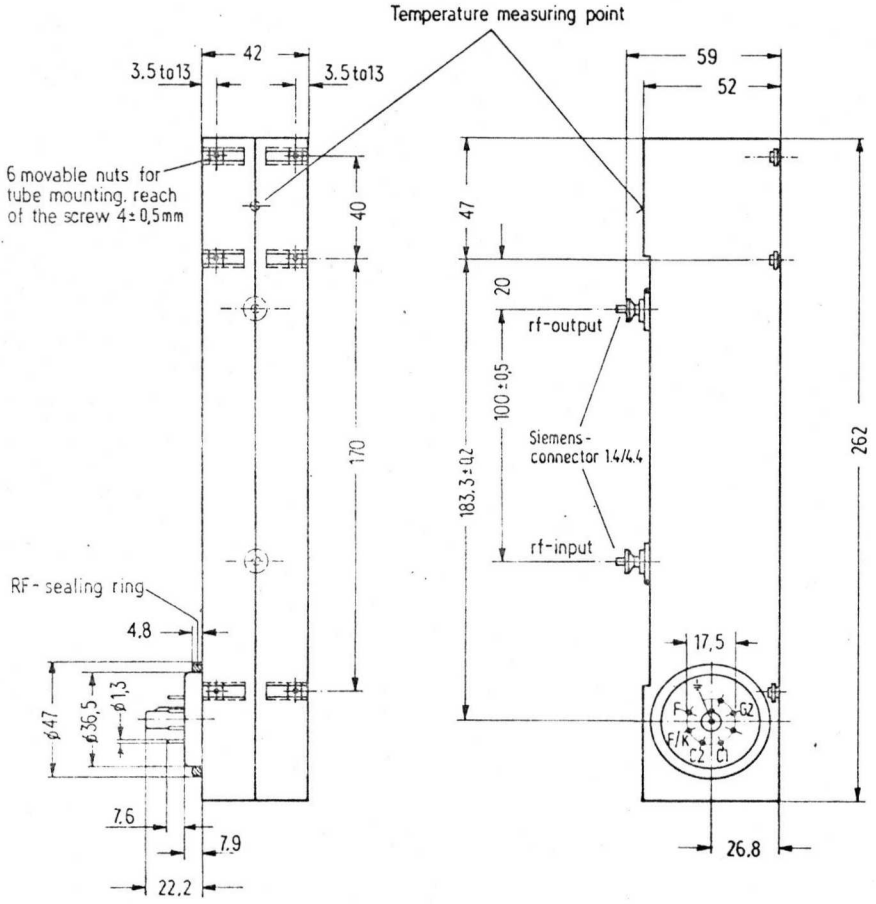
[1] A fix setting value for any frequency ranges will be stated later.
[2] It is adjusted at a power input of 1 mW for a power output of 11 W.
[3] AM/PM conversion is the phase shift of the output signal when changing the input by 1 dB.

Maximum Ratings (absolute values)

Cold collector 1 voltage	U_{C1O}	max	3000	V
Collector 1 voltage	U_{C1}	max	1800	V [1]
Collector 1 dissipation	P_{C1}	max	55	W
Cold collector 2 voltage	U_{C2O}	max	1000	V
Collector 2 voltage	U_{C2}	max	800	V [2]
Collector 2 dissipation	P_{C2}	max	50	W
Cold helix voltage	U_{HO}	max	3800	V
Helix voltage	U_H	max	3600	V
Helix current	I_H	max	4	mA [3]
Grid 2 voltage	U_{G2}	max	3600	V
Grid 2 current	I_{G2}	max	±0.3	mA
Cathode current	I_K	max	60	mA
Load reflection	P_{refl}	max	3	W
Case temperature	t_{case}	max	100	°C [4]
Ambient temperature	t_{amp}	min	−30	°C
Ambient temperature	t_{amp}	max	65	°C
Storage temperature	t_{stor}	min	−40	°C
Storage temperature	t_{stor}	max	70	°C
Storage life		max	5	years

[1] The collector 1 voltage must not fall more than 50 V below the indicated operating value (stability and accuracy included).
[2] The collector 2 voltage must not fall more than 30 V below the indicated operating value (stability and accuracy included).
[3] Switch-off value of the protection relay.
[4] Measured on the temperature measuring point (see drawing).

For operating instructions, recommendations for the design of a power supply and detailed datas please refer to the obligatory specifications.



C1 : Collector 1
C2 : Collector 2
G2 : Grid 2
F : Heater
F/K: Heater/Cathode
⏚ : Ground

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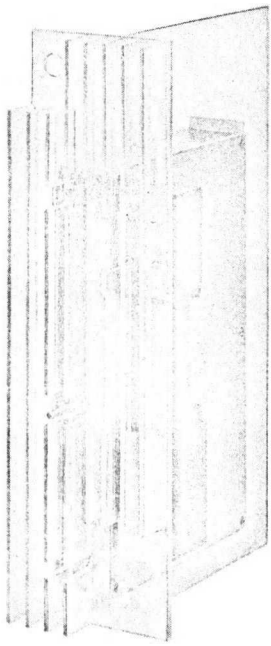
TWT-amplifier with long life and high reliability for broadband radio relay systems with a power output of 11 W in the frequency range 5.9 to 6.425 GHz.

It consists of a RW 88 tube and a RWN 88/24 power supply for 24 V supply voltage or RWN 88/30 for 30 V supply voltage (mounting recommendation see "drilling diagram for front panel").

The amplifier operates with a constant helix voltage. The power output will be set by a step switch for grid 2 voltage (single-dial control). For monitoring of cathode and helix current are provided connections. After switching off due to excessive helix current the power supply switches on 4 to 6 times until definit switch off. Further switch on cycles can be released by "Reset" command.

The total efficiency of the amplifier is nominal 23%.



Weight of tube:	approx. 1.4 kg (3.1 lbs)
Weight of power supply:	approx. 2.8 kg
Dimensions of tube:	approx. 46 mm × 54 mm × 262 mm (1.8" × 2.1" × 10.3")
Dimensions of power supply:	approx. 50 mm × 310 mm × 190 mm (2" × 12.2" × 7.5")
RF connections:	N connector, female
Low-voltage feed:	soldering terminals
Mounting position:	any

Typical Operation

Frequency range	f	5.9 to 6.425	GHz
Power output	P_2	11	W
Drive power	P_1	1.4 ±1 dB	mW
Setting accurancy of the power output with step-switch for grid 2 voltage		±0.25	dB
Gain slope	$\Delta Vp/\Delta f$	≈0.01	dB/MHz
Noise figure	F	≦25	dB
AM/PM conversion	k_p	≦5	°/dB [1]
RF-leakage		≧70	dB
Input current for RWA 88/24	I_1	≈2	A
Input current for RWA 88/30	I_1	≈1.6	A
Total efficiency	η total	≈23	%

[1] AM/PM conversion is the phase shift of the output signal when changing the input by 1 dB.

Required supply voltage data

RWA 88/24		
Voltage	$24 \pm 2\%$	V [1]
Current	2.5	A
RWA 88/30		
Voltage	$30^{+2.5}_{-0,5}$	V [1]
Current	2.0	A

Permissible voltage-current diagram see page 7

Impedance	0.1 Ω and 2 µA in series	
Ripple (100 Hz to 18 kHz)	≦120	mVpp
(18 kHz to 500 kHz)	≦ 10	mVpp
(>500 kHz)	≦ 5	mVpp
(equal for $I = 2.5$ or 2.0 A and resistive load)		

Maximum Ratings (absolute values)

Load reflection	P_{refl}	max	2.5	W
Operating temperature of tube case (see temperature measuring point)		max	115	°C
Power supply front plate temperature in operation (hottest point)		max	70	°C
Switching-on temperature		min	−20	°C
Storage temperature of tube			−40 to 70	°C
Storage temperature of power supply			−20 to 75	°C
Altitude		max	3000	m

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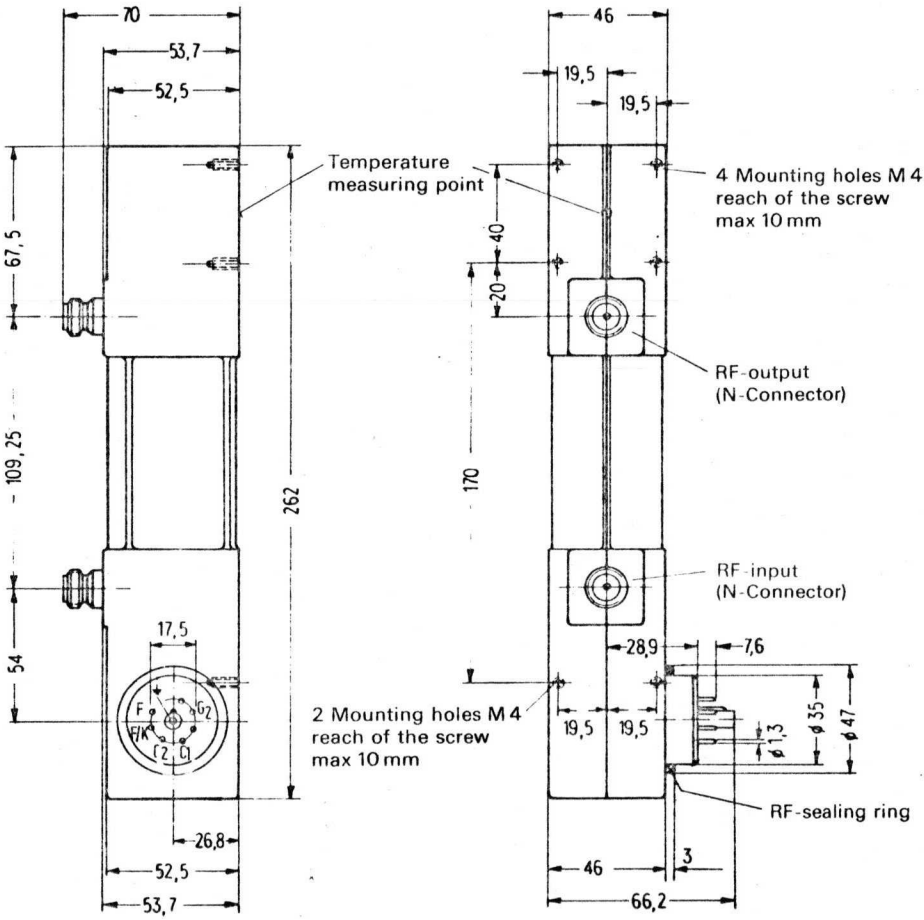
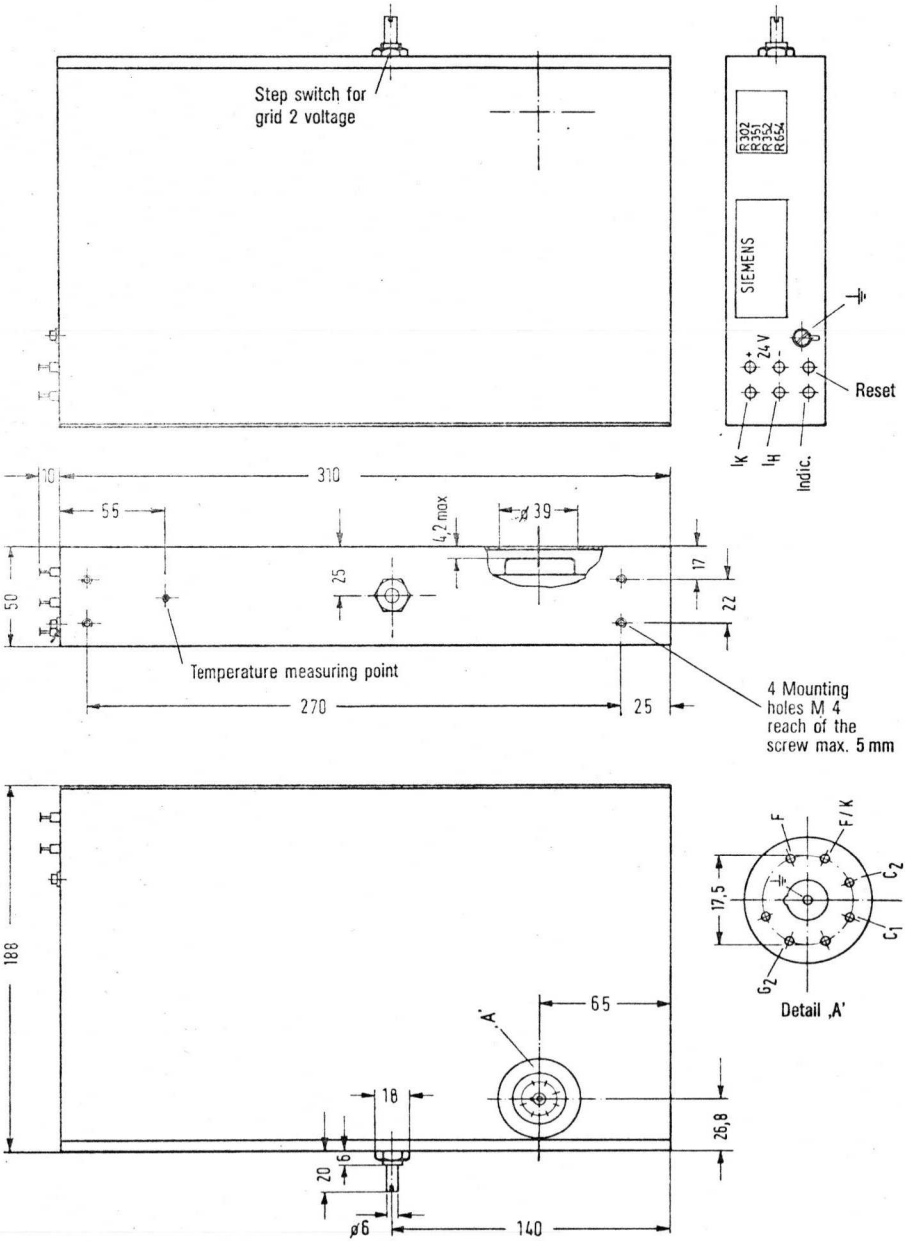
[1]) By choice minus or plus connected with case.

Drawing for tube RW 88

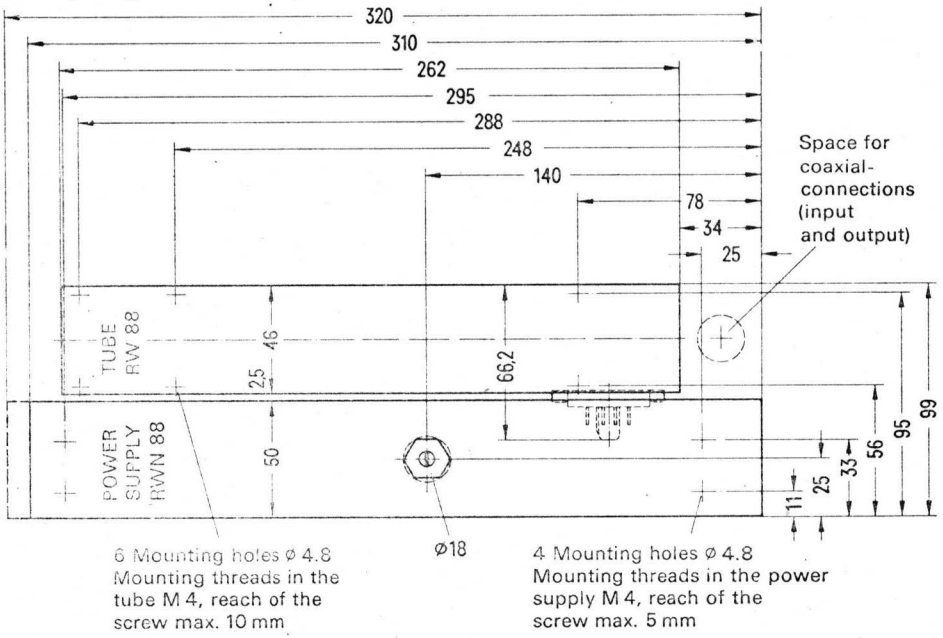


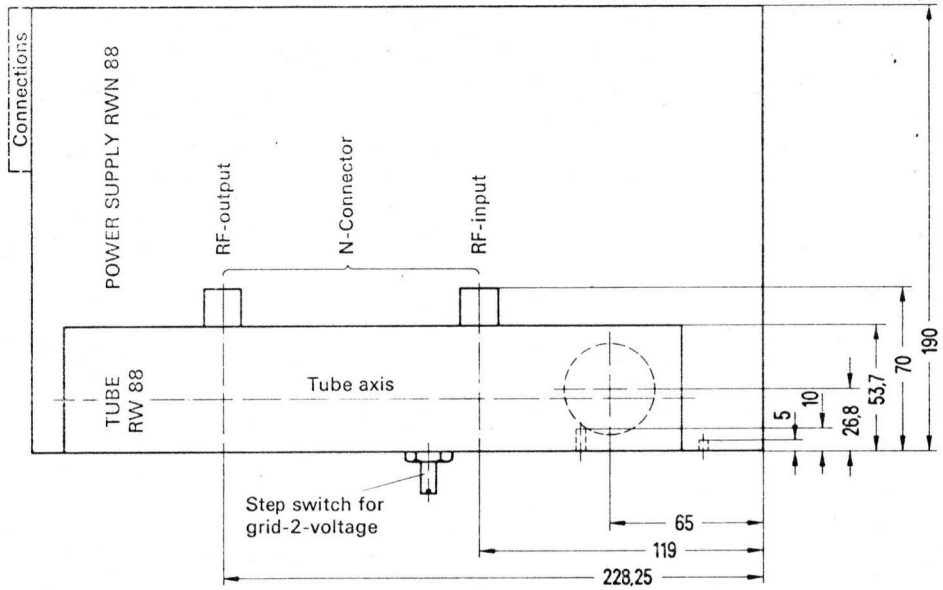
C1 : Collector 1
C2 : Collector 2
G2 : Grid 2
F : Heater
F/K : Heater/Cathode
⏚ : Ground

Drawing for power supply RWN 88/24 or RWN 88/30

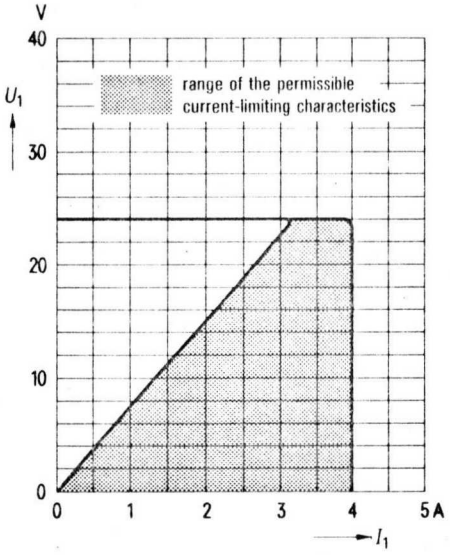


Drilling diagram for front panel

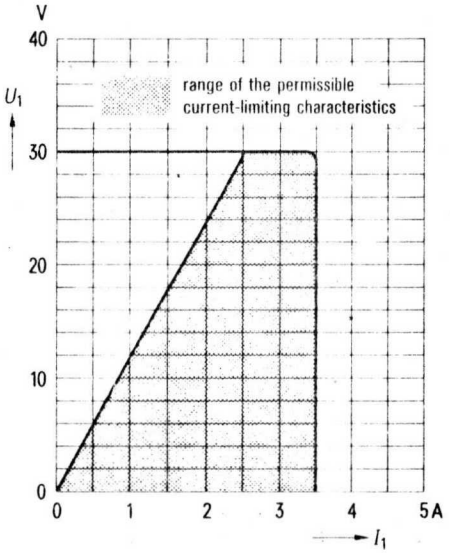




RWA 88/24: Permissible current-voltage range of the supply voltage



RWA 88/30: Permissible current-voltage range of the supply voltage



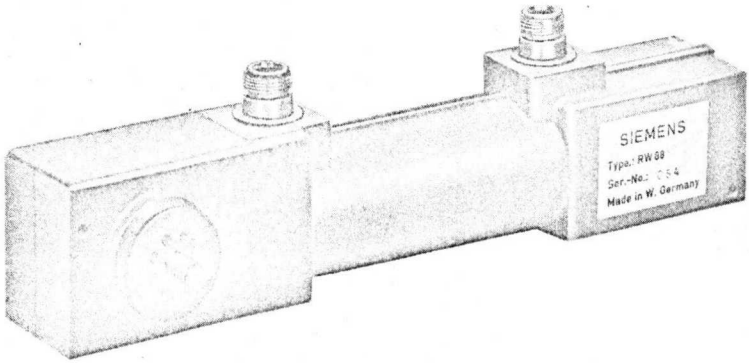
Order No. Q41-X3290
Q41-X3296

Conduction cooled power traveling wave tube with long life and high reliability for broadband radio relay systems with a power output of 11 W in the frequency range 5.9 to 6.425 GHz.

By using the most contemporary technic (double stage collector) an efficiency up to 35% is reached. The dissipated heat is low and indipendent of the RF input power. If the RF input power fails, no temperature rise will occur.

The tube is focused by an integrated periodic permanent magnet. The RF power is coupled in and out by way of coaxial connections.

For operation of the tube RW 88 a power supply can be delivered under the type-designation RWN 88/24 (supply voltage 24 V ±2%) or RWN 88/30 (supply voltage 30 to 32 V).



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Weight:	approx. 1.4 kg (3.1 lbs)
Dimensions:	approx. 46 mm x 54 mm x 262 mm (1.8"x 2.1"10.3")
RF connections:	N connector, female
Mounting position:	any

Heating

Heater voltage	U_F	6.3 ± 0.2	V	[1]
Heater current	I_F	0.64	A	
Preheating time	t_h	none		

indirect by dc, + pole on cathode, parallel supply
Metal capillary dispenser cathode

Characteristics ($f = 5.9$ to 6.425 GHz, $I_K = 23$ to 33 mA)

		min	nom	max		
Gain	V_p		39		dB	
Gain slope (Load VSWR ≦ 1.2)	$\Delta V_p/\Delta f$		0.01		dB/MHz	
VSWR cold	s			1.8		[2]
Cold attenuation	α	80			dB	

Typical Operation

Frequence range	f	5.9 to 6.425	GHz	
Power output	P_2	11	W	
Power input	P_1	1.4 ± 1 dB	mW	
Collector 1 voltage	U_{C1}	1300	V	
Collector 2 voltage	U_{C2}	650	V	
Helix voltage	U_H	$2375 \pm 1\%$	V	
Grid 2 voltage	U_{G2}	1200 to 1800	V	[3]
Cathode current	I_K	23 to 33	mA	
Collector 1 current with RF	I_{C1}	≈ 14	mA	
Collector 2 current with RF	I_{C2}	≈ 12	mA	
Collector 1 current without RF	$I_{C1\,0}$	≈ 1	mA	
Collector 2 current without RF	$I_{C2\,0}$	≈ 25	mA	
Helix current	I_H	≈ 1	mA	
Grid 2 current	I_{G2}	≦ ± 0.1	mA	
Noise figure	F	≦ 25	dB	
AM/PM conversion	k_p	≦ 5	°/dB	[4]
Total efficiency	η_{total}	≈ 34	%	

[1] If the maximum variation of the heater voltage exceeds the absolute limits of ± 0.2 V, the operating performance of the tube will be impaired and its life shortened.
[2] At input and output of cold tube in the frequency range 5.9 to 6.425 GHz.
[3] It is adjusted at a power input of 1.4 mW for a power output of 22 W.
[4] AM/PM conversion is the phase shift of the output signal when changing the input by 1 dB.

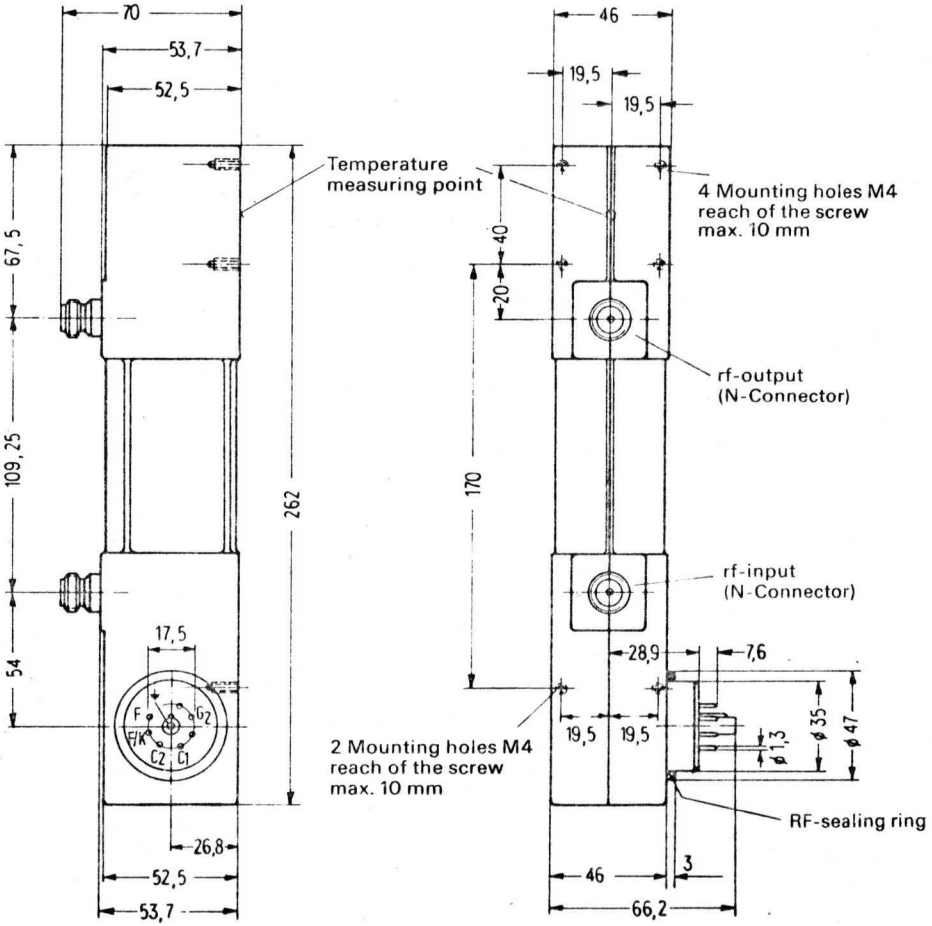
Maximum Ratings (absolute values)

Cold collector 1 voltage	$U_{C1\,0}$	max	2500	V	
Collector 1 voltage	U_{C1}	min	1250	V	
Collector 1 voltage	U_{C1}	max	1500	V	
Collector 1 dissipation	P_{C1}	max	30	W	
Cold collector 2 voltage	$U_{C2\,0}$	max	1200	V	
Collector 2 voltage	U_{C2}	min	600	V	
Collector 2 voltage	U_{C2}	max	800	V	
Collector 2 dissipation	P_{C2}	max	20	W	
Cold helix voltage	$U_{H\,0}$	max	3200	V	
Helix voltage	U_H	max	3000	V	
Helix current	I_H	max	4	mA	[1]
Grid 2 voltage	U_{G2}	max	3000	V	
Grid 2 current	I_{G2}	max	± 0.3	mA	
Cathode current	I_K	max	40	mA	
Load reflection	P_{refl}	max	2.5	W	
Case temperature	t_{case}	max	115	°C	[2]
Ambient temperature	t_{amb}	min	-30	°C	
Ambient temperature	t_{amb}	max	65	°C	
Storage temperature	t_{stor}	min	-40	°C	
Storage temperature	t_{stor}	max	70	°C	
Storage life		max	5	years	

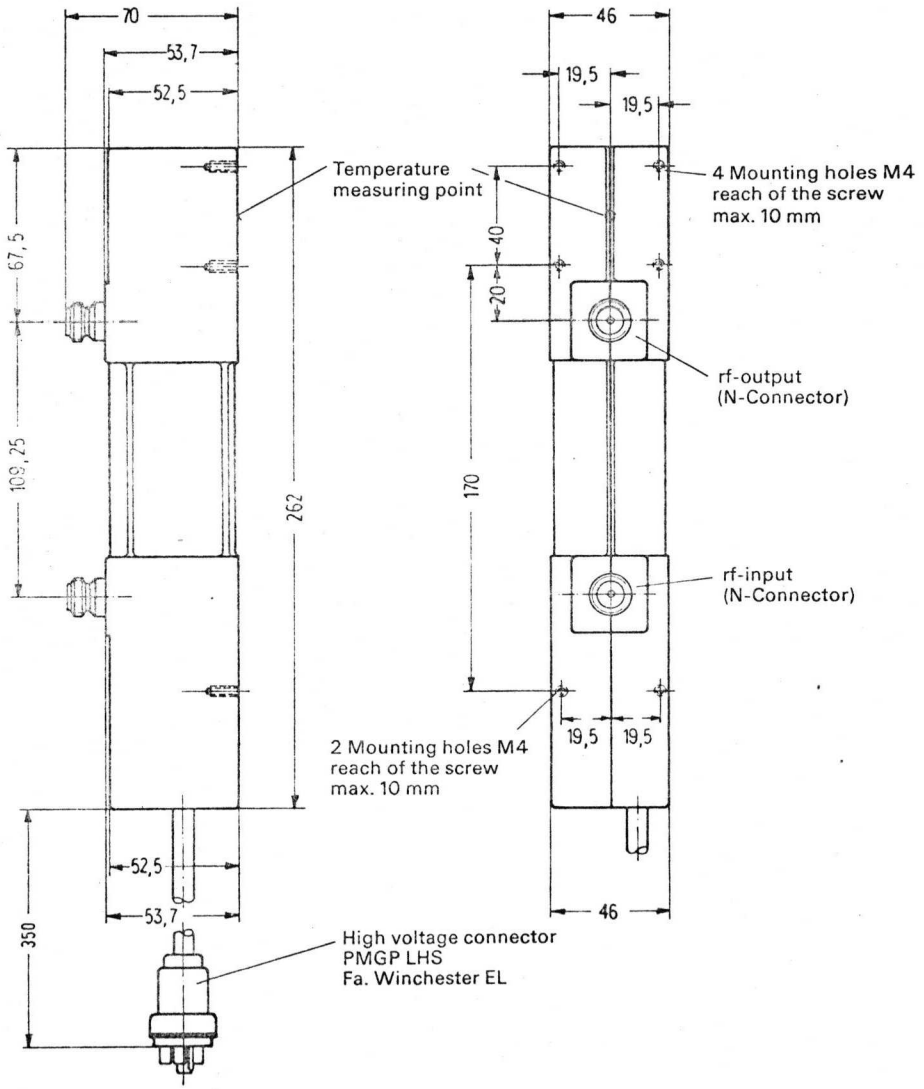
For operating instructions, recommendations for the design of a power supply and detailed datas please refer to the obligatory specifications.

[1] Switch-off value of the protection relay
[2] Measured on the temperature measuring point (see drawing)

Drawing RW 88



Drawing RW 88 C



for Traveling Wave Tube RW 88

Order No. Q87-X304
Q87-X330

The power supply RWN 88/24 or RWN 88/30 delivers all voltages necessary to operate the traveling wave tube RW 88 and includes the protective and controlling devices to protect the tube against overloads and damage.

The power supply type RWN 88/24 operate with a supply voltage of 24 V ± 2%, the power supply RWN 88/30 with $30\,^{+2.5}_{-0.5}$ V.

Mechanical Data (see page 6)

Height:	310 ± 1 mm
Width:	50 ± 1 mm
Depth:	190 ± 1 mm
Weight:	max. 2.8 kg

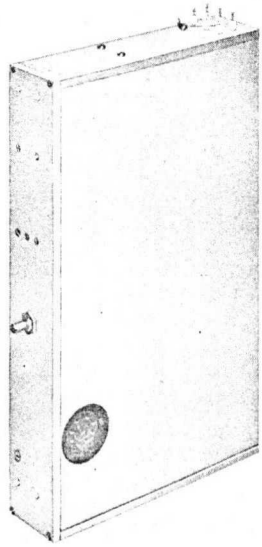
Low-voltage feed: soldering terminals
High-voltage connector: Siemens C42392

Reliability and Life

MTBF ≧ 120000 hours

Efficiency

η = 70 to 74% (dissipated heat of the power supply 16 to 19 W) (according to operation of traveling wave tube RW 88)



Required supply voltage data

RWN 88/24				
Voltage		24 ± 2%	V	[1]
Current		2.1 to 2.8	A	[2]
RWN 88/30				
Voltage		$30^{+2.5}_{-0.5}$	V	[1]
Current		1.7 to 2.2	A	[2]
Permissible voltage-current diagram		see page 7		
Impedance		0.1 Ω and 2 µH in series		
Ripple	(100 Hz to 18 kHz)	≦ 120	mVpp	
	(18 kHz to 500 kHz)	≦ 10	mVpp	
	(> 500 kHz)	≦ 5	mVpp	
	(equal for I = 3 A or 2,4 A and resistive load)			

At higher ripples and higher internal resistance of the supply voltage the ripple of the output voltages enlarges itself.

Environmental conditions

Temperature

Front plate temperature in operation (hottest point)	−10 to +70	°C
Switching-on temperature	min −20	°C
Storage temperature	−20 to +75	°C

Humidity (in operation)

95% up to t_{amb} = 40°C, linear decreasing to 50% at t_{amb} ≧ 50°C (not bedewed)

Altitude

Maximum permissible altitude 3000 m

Dissipated heat

The heat must be dissipated over the front plate.

[1] By choice minus or plus connected with case.
[2] According to operating of traveling wave tube RW 88 (11 or 15 W).

Output voltages

Heating

Voltage	U_F	6.3 ± 1%	V
Ripple	$u_{f\,mm}$	≦ 0.1	Vpp
Stability		≦ ± 3	%
Current range	I_F	0.5 to 0.7	A
Maximum current	$I_{F\,max}$	1.5	A

The heater voltage source is short-circuit proof for any length of time.

The heater voltage is changeable about ± 0.2 V by exchanging a resistor.

Helix

Voltage	U_H	2375 or 2400 ± 0.3%	V	[1]
Ripple	$u_{h\,mm}$	see page 7		
Stability		≦ ± 1	%	
Current range	I_H	0 to 4	mA	
Output impedance	Z_2 (0 to 1 Hz)	≦ 500	Ω	
	Z_2 (1 Hz to 10 MHz)	≦ 20	kΩ	
Output capacity	c_2	0.2	µF	

At an equal or higher I_H of 3.5 mA (± 10%) the load $Q_H = \int I_H \, dt$ will be proofed. If load is above 8 mAs (± 20%) the power supply switches off.

The helix voltage can be changed about ± 30 V by exchanging a resistor.

The helix voltage source is short-circuit proof until power supply is switched off.

[1] switchable

Grid 2

Voltage	U_{G2}	1200 to 1800	V
Ripple	$u_{g\,mm}$	see page 7	
Stability		$\leqq \pm 3$	%
Current range	I_{G2}	−0.3 to +0.3	mA
Output impedance	Z_2 (0 to 10 MHz)	$\leqq 150$	kΩ

The grid 2 voltage is adjustable from the front plate in steps of 50 V.

The grid 2 voltage range can be changed to 1350 to 1950 V soldering in a wire-bridge.

The gride 2 voltage source is short-circuit proof for any length of time.

Collectors

Collector 1 voltage	U_{C1}	1300^{+2}_{-1} %	V
Collector 2 voltage	U_{C2}	650^{+2}_{-1} %	V
Ripple	$u_{c\,mm}$	$\leqq 10$	Vpp
Stability within Environmentals		$\leqq \pm 1$	%
Open-circuit collector 1 voltage	U_{C1}	$\leqq 1700$	V
Open-circuit collector 2 voltage	$U_{C2\,o}$	$\leqq 850$	V
Collector 1 current	I_{C1}	0 to 35	mA [1]
Collector 2 current	I_{C2}	0 to 35	mA [1]
Output impedance (in the range 20 to 35 mA, 0 to 10 MHz)	Z_2	$\leqq 1.5$	kΩ

The collector voltage source is short-circuit proof for any length of time.

[1] The total collector current $I_{C1} + I_{C2}$ must be lower than 40 mA.

Switching processes

Switching-on

All voltages except the grid 2 voltage are arvailable at the terminals within 1.5 s following a switch-on pulse (result by applying the input voltage, by automatic switch on or by "Reset" command).

The grid 2 voltage is lower than 200 V. After 1 s the grid 2 voltage is switched to its nominal value (rise time τ approx. 200 ms).

Switching-off

The grid 2 voltage will be reduced to 200 V within 40 ms. All other voltages are reduced to 10% of its nominal value within 0.5 s.

Automatic switch on

After switching off due to excessive helix current the power supply switches on 4 to 6 times until definit switch off. Further switch on cycles can be released by "Reset" command.

Connecting points for test, control and signal purposes on the power supply RWN 88

Connection "Indic."

After response of the helix overload current protection device this connection will be switched to -pole of the 24 V supply voltage by a NPN transistor (60 V, 200 mA).

Connection "Reset"

By switching this connection to -pole of the 24 V supply voltage an automatic switch on cycle (Reset command) is released.

Connection "I_K"

For measurements of cathode current.
If a coil ammeter is used with $R_i = 2.5$ kΩ and full scale voltage of 500 mV the full scale voltage corresponds with $I_K = 50$ mA (±5%).

Connection "I_H"

For measurements of helix voltage.
If a coil ammeter is used with $R_i = 2.5$ kΩ and full scale voltage of 500 mV the full scale voltage corresponds with $I_H = 10$ mA (±2%).